

We claim:

1. A method of optical regeneration comprising in combination the steps of:  
exponentially amplifying a degraded input signal; and  
providing gain saturation to the exponentially amplified signal to form a  
5 regenerated output signal.
2. The method of claim 1, wherein the steps of exponentially amplifying and gain  
saturation are provided by two independent devices.
3. The method of claim 1, wherein the steps of exponentially amplifying and gain  
saturation are provided by a single device.
- 10 4. The method of claim 1, wherein the exponential amplification is provided by  
parametric amplification.
5. The method of claim 1, wherein the gain saturation is provided by a  
semiconductor optical amplifier.
6. The method of claim 1, wherein the gain saturation is provided by self-phase  
15 modulation induced supercontinuum generation of the input data used as a pump.
7. An apparatus for optical regeneration of degraded data, comprising:  
a parametric amplifier pumped by input data; and  
a continuous wave (CW) laser as the probe for the parametric amplifier;  
a saturation amplifier for receiving output from the parametric amplifier, wherein  
20 a regenerated output signal is generated.
8. The apparatus of claim 7, wherein the input signal is a non return-to-zero (NRZ).
9. The apparatus of claim 7, wherein the input signal is a return-to-zero (RZ).

10. The apparatus of claim 7, wherein the polarization of the CW laser is aligned with polarization of the input data.
11. The apparatus of claim 7, wherein the polarization of the CW laser is linear and aligned to have maximal overlap with polarization of the input data, and the  
5 power of the CW laser is controlled so that the power of regenerated data is independent of the state of polarization of the input data.
12. The apparatus of claim 7, wherein the parametric amplifier is an optical fiber with its zero-dispersion wavelength optimized for parametric amplification, which should be approximately the same as that of the wavelength of the input signal  
10 and the saturation amplifier is a semiconductor optical amplifier.
13. The apparatus of claim 12, wherein the fiber is a photonic crystal fiber.
14. The apparatus of claim 12, wherein the parametric amplification medium is a third nonlinear optical crystals.
15. The apparatus of claim 12, wherein the parametric amplification medium is a  
15 second-order nonlinear optical crystals used cascading third-order nonlinear optical material.
16. An apparatus for optical regeneration comprising:  
a pulsed light source;  
a parametric amplifier; and  
20 a saturation amplifier wherein input data is used as the pump for the parametric amplifier and output of the parametric amplifier is input into the saturation amplifier.
17. The apparatus of claim 16, wherein the pulsed light source is generated from:  
a clock signal recovered from the input data.

18. The apparatus of claim 16, wherein the input signal is a NRZ signal.
19. The apparatus of claim 16, wherein the input signal is a RZ signal.
20. The apparatus of claim 16, wherein the parametric amplifier is an optical fiber  
with its zero-dispersion wavelength optimized for parametric amplification, which  
5 should be approximately the same as that of the wavelength of the input signal  
and the saturation amplifier is a semiconductor optical amplifier.
21. The apparatus of claim 20, wherein the fiber is a photonic crystal fiber.
22. The apparatus of claim 21, wherein the parametric amplification medium is a third  
nonlinear optical crystals.
- 10 23. The apparatus of claim 21, wherein the parametric amplification medium is a  
second-order nonlinear optical crystals used cascading third-order nonlinear  
optical material.
24. The apparatus of claim 20, wherein the polarization of the pulsed light source is  
aligned with polarization of the input data.
- 15 25. The apparatus of claim 20, wherein the polarization of the pulsed light source is  
linear and aligned to have maximal overlap with polarization of the input data,  
and the power of the pulsed laser is controlled so that the power regenerated data  
is independent of the state of polarization of the input data.
26. An apparatus for optical regeneration comprising:  
20 a CW laser; and  
a saturating parametric amplifier, wherein input data is used as a pump for the  
saturating parametric amplifier.
27. The apparatus of claim 26, wherein the input signal is a NRZ signal.
28. The apparatus of claim 26, wherein the input signal is a RZ signal.

29. The apparatus of claim 26, wherein the parametric amplifier is an optical fiber with its zero-dispersion wavelength optimized for parametric amplification, which should be approximately the same as that of the wavelength of the input signal and the saturation amplifier is a semiconductor optical amplifier.
- 5 30. The apparatus of claim 26, wherein the polarization of the CW laser is aligned with polarization of the input data.
31. The apparatus of claim 26, wherein the polarization of the CW laser is linear and aligned to have maximal overlap with polarization of the input data, and the power of the CW laser is controlled so that the power regenerated data is
- 10 independent of the state of polarization of the input data.
32. The apparatus of claim 26, wherein the fiber is a photonic crystal fiber.
33. The apparatus of claim 26, wherein the parametric amplification medium is a third nonlinear optical crystals.
34. The apparatus of claim 26 wherein the parametric amplification medium is a
- 15 second-order nonlinear optical crystals used cascading third-order nonlinear optical material.
35. An apparatus for optical regeneration comprising:
- a pulsed laser source;
- a parametric amplifier; and
- 20 a saturation amplifier wherein input data is used as the pump for the parametric amplifier and output of the parametric amplifier is input into the saturation amplifier.
36. The apparatus of claim 35, wherein the pulsed laser source is generated from:
- a clock signal recovered from the input data.

37. The apparatus of claim 35, wherein the input signal is a NRZ signal.
38. The apparatus of claim 35 wherein the input signal is a RZ signal.
39. The apparatus of claim 35 wherein the parametric amplifier is an optical fiber  
with its zero-dispersion wavelength optimized for parametric amplification, which  
5 should be approximately the same as that of the wavelength of the input signal  
and the saturation amplifier is a semiconductor optical amplifier.
40. The apparatus of claim 39 wherein the fiber is a photonic crystal fiber.
41. The apparatus of claim 40 wherein the parametric amplification medium is a third  
nonlinear optical crystals.
- 10 42. The apparatus of claim 40 wherein the parametric amplification medium is a  
second-order nonlinear optical crystals used cascading third-order nonlinear  
optical material.
43. The apparatus of claim 35, wherein the polarization of the pulsed laser source is  
aligned with polarization of the input data.
- 15 44. The apparatus of claim 35 wherein the polarization of the pulsed laser source is  
linear and aligned to have maximal overlap with polarization of the input data,  
and the power of the pulsed laser source is controlled so that the power  
regenerated data is independent of the state of polarization of the input data.
- 45 An apparatus for optical regeneration comprising:  
20 a pulsed laser source; and  
a saturating parametric amplifier, wherein input data is used as a pump for the  
saturating parametric amplifier.
46. The apparatus of claim 45, wherein the input signal is a NRZ signal.
47. The apparatus of claim 45 wherein the input signal is a RZ signal.

48. The apparatus of claim 45 wherein the parametric amplifier is an optical fiber with its zero-dispersion wavelength optimized for parametric amplification, which should be approximately the same as that of the wavelength of the input signal and the saturation amplifier is a semiconductor optical amplifier.
- 5 49. The apparatus of claim 45 wherein the polarization of the pulsed laser source is aligned with polarization of the input data.
50. The apparatus of claim 45 wherein the polarization of the pulsed laser source is linear and aligned to have maximal overlap with polarization of the input data, and the power of the pulsed laser source is controlled so that the power
- 10 regenerated data is independent of the state of polarization of the input data.